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# NDE Publications: 1978

Leonard Mordfin, editor

Office of Nondestructive Evaluation  
National Measurement Laboratory  
National Bureau of Standards  
U.S. Department of Commerce  
Washington, DC 20234

December 1979

Issued June 1980



U.S. DEPARTMENT OF COMMERCE

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**Luther H. Hodges, Jr., *Deputy Secretary***

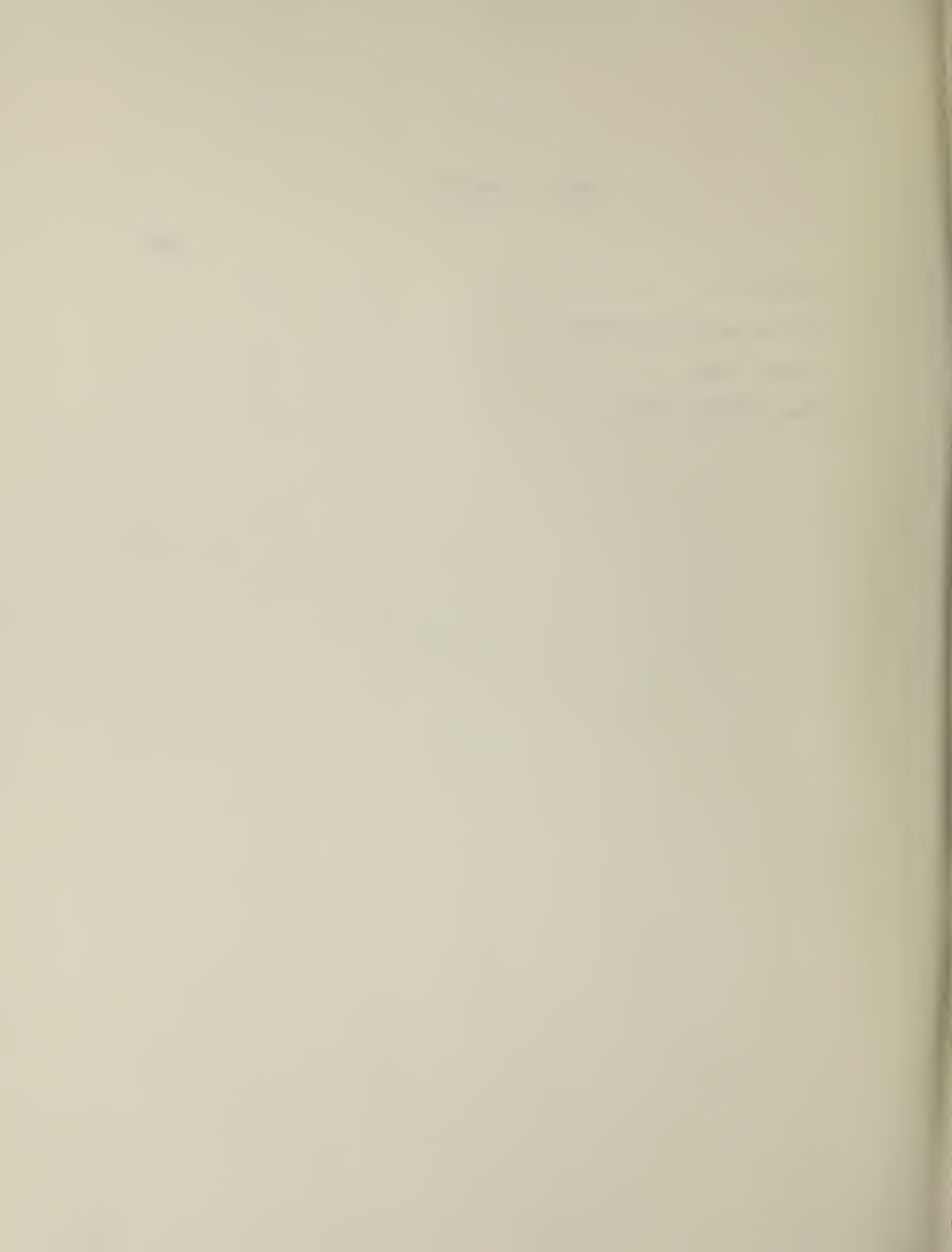
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## NDE PUBLICATIONS: 1978

Leonard Mordfin

Office of Nondestructive Evaluation  
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Washington, DC 20234

### 1. Introduction

This report is the first annual supplement to NBSIR 78-1557, "NDE Publications: 1972-1977". It presents a bibliography of NBS publications on nondestructive evaluation that appeared in the open literature during calendar year 1978. Also included are citations for several publications that appeared in 1977 or prior years but were not listed in the previous compilation. Almost all of these publications were authored by members of the NBS staff and include papers published in non-NBS media as well as papers and reports from the NBS publications series. A few of the publications cited were written for NBS media by non-NBS authors.

These publications address a wide variety of NDE methods, both those that are widely used in industry and some that are relatively new. For completeness, several publications dealing with technologies that directly support NDE, such as pattern recognition and piezoelectricity, have been included.

The format of this report is the same as that used previously, with one major exception; brief, edited abstracts are provided for most of the 1978 citations. The bibliography and the abstracts comprise Section 2 of this report. The first 59 entries in the bibliography are listed in alphabetical order by the surname of the first author. The last thirteen entries, Nos. 60 through 72, were added later and do not follow this sequence.

Section 3 of the report is a subject index for the publications listed. This index is quite comprehensive and, when used together with the abstracts and the alphabetical bibliography, may be expected to enable readers to locate publications of interest without difficulty.

The last section of the report provides some assistance to readers wishing to obtain copies of specific publications listed.

Present plans call for issuance of a 1979 supplement in about a year. To this end, corrections or suggestions for improving the format would be welcomed. Comments should be directed to the Office of Nondestructive Evaluation, National Bureau of Standards, Washington, DC 20234.



## 2. Bibliography and Abstracts

1. Albus, J. S., Hierarchical interaction between behavior generation and pattern recognition, Proc. Seventh Annual Automation Imagery Pattern Recognition Symp., College Park, MD, May 23-24, 1977, pp. 343-383 (Electronic Industries Assoc., Washington, DC, 1977).
2. Belanger, B. C., The role of NBS in traceability to national standards for advanced measurement systems, Proc. Industry/Joint Services Automatic Test Conf. and Workshop on Advanced Test Technology Management and Support, San Diego, CA, Apr. 3-7, 1978, pp. 295-296 (National Security Industrial Association, Washington, DC, 1978).

NBS's role in traceability to national standards for automated test equipment (ATE) is described. The meaning of traceability vis-a-vis ATE is discussed.

3. Bennett, L. H., Page, C. H., Swartzendruber, L. J., Comments on units in magnetism, J. Res. Nat. Bur. Stand. (U.S.), 83, No. 1, 9-12 (Jan.-Feb., 1978).

Suggestions are given on how to express magnetic quantities in SI units.

4. Berger, H., Californium-252 as a source for thermal neutron radiography, Proc. Int. Symp. on Californium-252 Utilization, Paris, France, Apr. 26-28, 1976, pp. V-1 to V-14 (E. I. du Pont de Nemours and Co., Aiken, SC, 1978).

Thermal neutron radiography is compared to other methods for nondestructive evaluation; it is shown to offer advantages in many aerospace and nuclear inspection areas. Descriptions and economics of neutron sources including reactors, subcritical assemblies, accelerators and radioactive sources are given. All can be considered for in-plant inspection use; the higher yield sources offer initial economic advantages. Radioactive sources are well suited for field applications.

5. Berger, H., Mordfin, L., Calibrations and standards for nondestructive testing, Mater. Eval. 36, No. 11, 36-39 (American Society for Nondestructive Testing, Evanston, IL, Oct., 1978).

Improved nondestructive testing (NDT) standards and calibrations are needed to provide greater reproducibility of NDT measurements and to provide improvements in the quantitative characterization of defects. Different calibration and standards concepts may be required to meet these two needs. This theme is developed and illustrated by radiographic measurements of Trans-Alaska oil pipeline girth welds.



6. Berger, H., Nondestructive testing standards--The role of NBS, Proc. 1978 Annual Meeting American Nuclear Society on Nondestructive Testing in the Nuclear Power Industries, San Diego, CA, June 18-22, 1978, 28, 124-125 (American Nuclear Society, Inc., La Grange Park, IL, 1978).

Reliable, reproducible and meaningful nondestructive inspection has been a goal of the nuclear power industry from the beginning. A new NBS program, Nondestructive Evaluation (NDE), is beginning to contribute toward that goal for nuclear power and other quality-conscious industries. A near-term objective of the program is to provide means to improve nondestructive measurement reliability and reproducibility. The long-term objective of the NBS work is to gain a better understanding of the meaning of NDE measurements in terms of material or system performance.

7. Birnbaum, G., "New" candidates for ultrasonic NDE standards and calibrations, Proc. ARPA/AFML Review of Progress in Quantitative NDE, Ithaca, NY, June 14-17, 1977, Report AFML-TR-78-55, pp. 289-293 (Air Force Materials Laboratory, Wright-Patterson Air Force Base, OH, May 1978).

The National Bureau of Standards program in acoustic-ultrasonic calibrations and standards, aimed at solving some of the immediate problems, is reviewed. However, many other standards and calibration procedures for ultrasonic NDE have been proposed or are in use.

To provide a fresh look at this area, particularly as it applies to DoD systems, NBS has initiated a program funded by ARPA to assess the status of the field, determine current and future needs, and propose a plan for realizing these needs.

8. Blackburn, D. L., Rubin, S., A nondestructive method for the determination of forward-biased safe-operating-area limits for power transistors, Proc. 1977 Power Electronics Specialists Conf., Palo Alto, CA, June 14-16, 1977, pp. 17-22 (Oct. 1977).
9. Blackburn, D. L., Photovoltaic technique for measuring resistivity variations of high resistivity silicon slices, J. Res. Nat. Bur. Stand. (U.S.), 83, No. 3, 265-271 (May-June 1978).

A description of an automated, photovoltaic system for measuring the resistivity variation of high resistivity, large diameter silicon wafers is given. The photovoltaic technique utilizes a scanning light spot to induce a bulk photovoltage and a change in resistance from which is calculated the local variation in resistivity. This nondestructive technique requires no contacts to the useful fabrication area of the wafer.

10. Block, S. (Chairman, ANSI Subcommittee N43-1), American National Standard N43.2; Radiation safety for x-ray diffraction and fluorescence analysis equipment, Nat. Bur. Stand. (U.S.), Handb. 111 Revised, 20 pages (May 1978) SN003-003-01917, \$1.00.

This standard reviews the types of injuries resulting from accidental exposure to ionizing radiation resulting from the operation of x-ray diffraction and fluorescence analysis equipment, establishes equipment design criteria, sets up requirements for approved operating procedures, and recommends the establishment of health surveillance, and personnel monitoring programs.

11. Broadhurst, M. G., Davis, G. T., McKinney, J. E., Collins, R. E., Piezoelectricity and pyroelectricity in polyvinylidene fluoride--A model, J. Appl. Phys. 49, No. 10, 4992-4997 (Oct. 1978).

A description is given of the molecular and morphological structure of polyvinylidene fluoride and a classical model is proposed for calculating the piezoelectric and pyroelectric properties.

12. Busching, H. W., Mathey, R. G., Rossiter, W. J., Jr., Cullen, W. C., Effects of moisture in built-up roofing--A state-of-the art literature survey, Nat. Bur. Stand. (U.S.), Tech. Note 965, 78 pages (July 1978) SN003-003-01944-5, \$2.40.

A literature review of the effects of moisture on built-up roofing was made. Nondestructive evaluative methods to locate moisture in roofing systems were summarized and include gravimetric, nuclear, capacitance, infrared imagery, electrical resistance, and microwave methods.

13. Caswell, R. S., Neutron measurement intercomparisons, (Proc. Intl. Course at Varenna, Italy, Sept.-Oct. 1974), Paper D-1 in Ionizing Radiation Metrology, pp. 113-132 (Editrice Compositori Bologna, Italy, 1977).

14. Christou, A., Semiconductor measurement technology: Automated scanning low-energy electron probe (ASLEEP) for semiconductor wafer diagnostics, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-30, 38 pages (Apr. 1978) SN003-003-01905-4, \$1.50.

15. Chwirut, D. J., Boswell, G. D., The evaluation of search units used for ultrasonic reference block calibrations, NBSIR 78-1454, 30 pages (Feb. 1978). Order from NTIS as PB280311, \$4.50.

The effects of using different (nominally identical) quartz search units in the evaluation of ASTM-type standard reference blocks are determined. Various characteristics of the search units are measured and correlated with the amplitude of the ultrasonic

response from reference blocks to determine which characteristics must be specified if reproducible results are to be obtained. It is shown by a series of experiments that the exact shape of the distance-amplitude curve in water (axial profile) is a primary characteristic that must be considered. When operational corrections for differences in axial profiles are made, the variability in ultrasonic responses from reference blocks, measured with different search units, is reduced from about 25 percent to 4 percent.

16. Cramp, A. P., Berger, H. W., The development of improved portable x-ray fluorescent lead paint analyzers and lead paint reference standards, Proc. 4th Joint Conf. on Sensing of Environmental Pollutants, New Orleans, LA, Nov. 6-11, 1977, pp. 354-359 (American Chemical Society, Washington, DC, 1978).

Portable x-ray fluorescent lead analyzers offer the most cost effective rapid and adaptable means for the nondestructive detection and measurement of lead paint in housing. This paper discusses the performance and operating characteristics of the lead analyzers developed under HUD contracts and the lead paint reference materials developed by the National Bureau of Standards.

17. Cramp, A. P., Berger, H. W., Evaluation of new portable x-ray fluorescent lead analyzers for measuring lead in paint, NBSIR 78-1466, 59 pages (May 1978). Order from NTIS as PB282254, \$5.25.
18. Davis, G. T., Broadhurst, M. G., Piezoelectricity and pyroelectricity in polar polymers, Proc. Intl. Symp. on Electrets and Dielectrics, Sao Carlos, Brazil, Sept. 1-6, 1975, pp. 299-319 (Instituto de Física e Química de Sao Carlos, Universidade de Sao Paulo, 13560 Sao Carlos, SP, Brazil, 1977).
19. Davis, G. T., Broadhurst, M. G., Piezoelectricity and pyroelectricity in a polyvinylidene fluoride copolymer, (Proc. Conf. on Electrical Insulation and Dielectric Phenomena, Gaithersburg, MD, Nov. 3-6, 1975), 1975 Annual Report, pp. 37-44 (National Academy of Sciences, Washington, DC, 1978).
20. Davis, G. T., McKinney, J. E., Broadhurst, M. G., Roth, S. C., Electric-field-induced phase changes in poly(vinylidene fluoride), J. Appl. Phys. 49, No. 10, 4998-5002 (Oct. 1978).
21. Dick, C. E., Motz, J. W., New method for the experimental evaluation of x-ray grids, Med. Phys. 5, No. 2, 133-140 (Mar.-Apr. 1978).
22. Dick, C. E., Soares, C. G., Motz, J. W., X-ray scatter data for diagnostic radiology, Phys. Med. Biol. 23, No. 6, 1076-1085 (1978).

The ratio of the scattered to the total x-ray fluence (scatter fraction) at the center of the image plane for x-rays transmitted through polystyrene phantoms has been measured.



23. Dietz, D. R., Norton, S. J., Linzer, M., Wideband annular array response, (Proc. 1978 Ultrasonics Symp.), IEEE Cat. No. 78CH 1344-1 SU, pp. 206-211 (Institute of Electrical and Electronic Engineers, New York, NY, 1978).

Theoretical calculations and experimental measurements of the response of a wideband annular array are presented.

24. Duvall, K. C., Meier, M. M., Wasson, O. A., Huynh, V. D., Neutron flux intercomparison at NBS, J. Res. Nat. Bur. Stand. (U.S.), 83, No. 6, 555-561 (Nov. - Dec. 1978).

NBS participation in an International Bureau of Weights and Measures sponsored neutron flux intercomparison is described. The efficiencies of two transfer instruments were determined and compared to the quantities determined at other participating standards laboratories.

25. Edelman, S., Piezoelectric and pyroelectric polymer sensors, Proc. Conf. on Sensor Technology for Battlefield and Physical Security Applications, Fort Belvoir, VA, July 13-15, 1977, pp. 204-212 (U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, July 1977).
26. Eisenhower, E. H. (Chairman, ANSI Subcommittee N43-3.4), American National Standard N433.1; Safe design and use of self-contained, dry storage gamma irradiators (Category I), Nat. Bur. Stand. (U.S.), Handb. 127, 22 pages (July 1978) SN003-003-01913-5, \$1.10.

This standard applies to self-contained, dry source storage irradiators (Category I) that contain sealed gamma emitting sources for the irradiation of objects or materials. It establishes the criteria to be used in the proper design, fabrication, installation, use, and maintenance of these irradiators which will ensure a high degree of radiation safety at all times.

27. Eisenhower, E. H. (Chairman, ANSI Subcommittee N43-3.3), American National Standard N542; Sealed radioactive sources, classification, Nat. Bur. Stand. (U.S.), Handb. 126, 28 pages (July 1978) SN003-003-01903-8, \$1.20.

This standard establishes a system of classification of sealed radioactive sources based on performance specifications related to radiation safety. It provides a manufacturer of sealed sources with a series of tests for evaluating the safety of his product under specified conditions, and also assists a user of such sources to select a type which suits the intended application insofar as maintenance of source integrity is concerned.

28. Ellerbruch, D. A., Belsher, D. R., Electromagnetic technique of measuring coal layer thickness, IEEE Trans. Geosci. Electron. GE-16, No. 2, 126-133 (Apr. 1978).

An FM-CW microwave system was investigated for measuring coal layer thickness. Measurements were made in three different mines. The results indicate that layer thickness can be determined in most cases.

29. Engen, G. G., Advances in microwave measurement science, Proc. IEEE 66, No. 4, 374-384 (Apr. 1978).

With the recent impact of digital technology, a review of the subject of microwave measurements is timely. Following a brief summary of those features which make this a unique science, the current status of the so-called "basic standards" for microwave measurements is noted. This is followed by a review of the use of digital techniques, power equation concepts, connector problems, and related developments. Finally, certain projections for the future are made.

30. Evans, J. M., Jr., Keynote address, Proc. Second Conf. Automatic Inspection and Product Control, Chicago, IL, Oct. 19-21, 1976, pp. XIII-XXIII (IIT Research Institute, Chicago, IL, 1976).

31. Feldman, A., Measurement of the photoelastic constants of optical materials, Opt. Eng. 17, No. 5, 453-462 (Sept.-Oct. 1978).

The photoelastic constants describe the effect of stress or strain on the refractive indices of material. Interferometric and polarimetric techniques are described for measuring piezo-optic coefficients under static loading conditions. Acousto-optic and Brillouin scattering techniques are described for measuring elasto-optic constants.

32. Fong, J. T., Uncertainties in fatigue life prediction and a rational definition of safety factors, Nuclear Engineering and Design 51, 45-54 (1978).

To cope with uncertainties in mechanical and structural design, engineers exercise their judgement through the use of safety factors based on service experience and laboratory data on relevant design parameters. The relationship between the size of a safety factor and the associated risk and cost-benefit estimates of the engineering function, for a given set of data, is exhibited. A system of ranking the importance of different sources of uncertainties, based on an analysis of service data, is proposed along with an example to "refine" the system using up-to-date laboratory and field measurements. The concept of a rational definition of safety factors as a tool for engineers who design under uncertainty is discussed.

33. Fong, J. T., Editor, Inservice data reporting and analysis for pressure vessels, piping, pumps and valves, PVP-PB-032, ASME Bk. No. H00137, 242 pages (American Society of Mechanical Engineers, New York, NY, 1978).

This volume contains thirteen papers presented at a symposium on technical issues which are faced in connection with the safe operations of pressure vessels, piping, pumps and valves.

34. Grabner, L., Spectroscopic technique for the measurement of residual stress in sintered  $Al_2O_3$ , J. Appl. Phys. 49, No. 2, 580-583 (Feb. 1978).

Using the R-line fluorescence of trace  $Cr^{3+}$  in sintered alumina as an example, a method of analysis is outlined for determining the residual microstress and macrostress in a polycrystalline aggregate. It uses the shift and broadening, induced by residual stress, of a line due to a transition in an atomic system dissolved in the aggregate.

35. Greenspan, M., Breckenridge, F. R., Tschiegg, C. E., Ultrasonic transducer power output by modulated radiation pressure, J. Acoust. Soc. Am. 63, No. 4, 1031-1038 (Apr. 1978).

We have set up and are using an apparatus for the measurement of total sound power output of a piezoelectric transducer radiating into water. This input is modulated at a low frequency and the output power is intercepted by a target which experiences a force at the modulation frequency. The target is mounted on the armature of an electromagnetic receiver provided with an independent coil through which a current at the modulation frequency is adjusted in amplitude and phase, either manually or automatically by feedback, to arrest the motion of the armature. When the armature is stationary the force depends only on the current, and the apparatus can be calibrated using direct current and dead weights. It is thus absolute.

36. Greenspan, M., Breckenridge, F. R., Tschiegg, C. E., Ultrasonic transducer power output by modulated radiation pressure (with details), NBSIR 78-1520, 53 pages (July 1978). Order from NTIS as PB289961, \$5.25.

37. Heydemann, P. L. M., The exact fractions interferometer, Proc. 1976 Ultrasonics Symp., Annapolis, MD, Sept. 29-Oct. 1, 1976, pp. 649-652 (Institute of Electrical and Electronics Engineers Group on Sonics and Ultrasonics, New York, NY, 1976).

38. Hirshfield, A. T., Hoppes, D. D., Schima, F. J., Germanium detector efficiency calibration with NBS standards, Proc. ERDA X- and Gamma-Ray Symp., Ann Arbor, MI, May 19-21, 1976, pp. 90-93 (Available as ERDA Conf. 760539 from NTIS, 1976).



39. Kirsch, R. A., Algorithms for image analysis of wood pulp fibers, NBSIR 78-1442, 30 pages (Jan. 1978). Order from NTIS as PB278622, \$4.50.

Image analysis technology can be used to measure the visible morphology of pulp fibers. But before such measurements can be accepted, it is necessary to achieve precise definition of the necessary measurements in the form of suitable algorithms that have been experimentally tested on images of actual fiber data. We present such measurement results on both semiautomatically traced fiber and on automatically scanned images. We suggest that the specification of the precise image analysis measurements needed in paper manufacturing can facilitate a technology for process control that will result in savings in paper manufacturing cost and in reduction of energy requirements.

40. Koyama, R. Y., Detection of deep levels in high power semiconductor materials and devices, J. Res. Nat. Bur. Stand. (U.S.), 83, No. 3, 273-281 (May-June 1978).

TSM and other deep level measurement techniques are used to detect, characterize, and identify deep level defects which control lifetime and leakage in semiconductor devices. Measurements of the gold acceptor defect density in silicon reveal inhomogeneity in the defect distribution which is directly reflected in the leakage current distribution. This apparatus is a useful extension of routine fabrication-line diagnostic tools.

41. Kruger, J., Bertocci, U., Escalante, E., Mullen, J. L., Development of in-situ techniques for the detection and measurement of corrosion of copper concentric neutrals in underground environments, NBSIR 78-1486, 60 pages (June 1978). Order from NTIS as PB283708, \$5.25.

The report describes work to develop in-situ methods for detecting corrosion on buried copper wires. Potential and polarization measurements on buried cables have been performed, and methods for distinguishing the signals of interest from interference due to a.c. applied to the cables, as well as d.c. earth currents, have been developed. Laboratory measurements to test possible corrosion detection techniques have been performed. Analysis of electrochemical noise has been developed and tested, and measurements on some electrochemical systems carried out.

42. Linzer, M., Dietz, D., Parks, S. I., Development of high-sensitivity ultrasonic techniques for in-service inspection of nuclear reactors, NUREG-CR-0460, 34 pages (Oct. 1978). Order from NTIS.

An ultrasensitive ultrasonic system, incorporating real-time signal averaging, pulse compression, dynamic focusing and transducer matching, has been developed. The system was shown to be capable of penetrating highly-attenuating material, such as austenitic steel, and of detecting reflections in the presence of strong background signals due to grain scattering.



43. McKinney, J. E. Davis, G. T., Piezo- and pyroelectricity of poly (vinylidene fluoride) from plasma poling, (Proc. 175th Meeting of the American Chemical Society, Anaheim, CA, Mar. 12-17, 1978), Paper in Organic Coatings and Plastics Chemistry 38, 271-277 (American Chemical Society, Washington, DC, 1978).

A plasma poling device is described which allows essentially instantaneous poling of polymeric films at room temperature at very high fields. The piezoelectric coefficients were measured and compared with those estimated from the theory of Mopsik and Broadhurst. The theory gives an accurate representation of the piezoelectric coefficients.

44. Mordfin, L., Ed., NDE publications: 1972-1977, NBSIR 78-1557, 35 pages (Nov. 1978). Order from NTIS as PB289755, \$4.50.

This report is a bibliography of 211 NBS publications on NDE and related technologies for the years 1972 through 1977. A detailed subject index is included, as well as information on how copies of many of the publications may be obtained. A preface by Harold Berger, Chief of the NBS Office of Nondestructive Evaluation, cites several early and significant NBS contributions to NDE, some of them dating back fifty years or more.

45. Motz, J. W., Danos, M., Image information content and patient exposure, Med. Phys. 5, No. 1, 8-22 (Jan.-Feb. 1978).

Presently, patient exposure and x-ray tube kilovoltage are determined by image visibility requirements on x-ray film. With image-processing techniques, image visibility may be manipulated and the exposure may be determined only by the desired information content. This work gives quantitative relationships between image information content and patient exposure. Also, for subject thickness larger than approximately 5 cm, the maximum information content may be obtained at a single kilovoltage and filtration with the simultaneous employment of image-enhancement and antiscatter techniques.

46. Novotny, D. B., Ciarlo, D. R., Semiconductor measurement technology: Automated photomask inspection, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-46, 38 pages (Apr. 1978) SN003-003-01912-7, \$1.50.

Methods suitable for automated photomask inspection for visual defects (spots, pinholes, etc.) or dimensional compliance are analyzed and discussed. The analysis includes examinations of the physical principles and the amount of misalignment that can be tolerated. The methods analyzed for visual defect inspection are the optical-overlay; the dual-beam, flying-spot-scanner; the TV-microscope; and the spatial-filtering methods. For dimensional inspection, an analysis of line-edge location and operating criteria for the microdensitometer are presented.

47. Prince, E., Wlodawer, A., Santoro, A., Flat-cone diffractometer utilizing a linear position-sensitive detector, J. Appl. Cryst. 11 173-178 (1978).

The recent development of linear position-sensitive detectors for neutrons and x-rays leads to the possibility of large improvements in the efficiency of data collection in single-crystal diffractometers. In order to take advantage of the properties of a linear position-sensitive detector it is desirable to use a diffraction geometry which causes the diffracted beams from many different reflecting planes to lie in a common plane. A diffractometer utilizing the flat-cone geometry has been constructed.

48. Read, D. T., Ledbetter, H. M., Temperature dependence of the elastic constants of an NbTi/Cu superconducting composite, Composites 9, No. 2, 100-104 (Apr. 1978).

Low-temperature elastic properties are reported for a commercial superconducting composite consisting of niobium-titanium filaments in a copper matrix. Both an ultrasonic pulse-superposition technique and a composite-oscillator technique were used.

49. Reite, M., Zimmerman, J., Magnetic phenomena of the central nervous system, Ann. Rev. Biophys. Bioeng. 7, 167-188 (1978).

Several laboratories have contributed to the present state of knowledge of magnetic phenomena of the central nervous system. A useful feature of magnetic detection is that sources in the brain can be localized more precisely, and more easily, than by surface electric potential measurements.

50. Reneker, D. H., Edelman, S., DeReggi, A. S., Vanderhart, D. L., An ndt method using piezoelectric polymer transducers and computerized vibrational spectroscopy, NDT Intl. 11, No. 1, pp. 15-16 (Feb. 1978).

The normal mode vibrational spectrum of an object contains a wealth of information about the mechanical integrity of the object. The nondestructive evaluation of objects by observation of their vibrational spectra is facilitated by the combination of recently developed low mass, high compliance piezoelectric polymer transducers; a synchronized method for exciting the sample; and a small minicomputer capable of making digital Fourier transforms which convert the complicated, oscillatory, decaying signal from the transducer into the intensities and frequencies of normal modes.

51. Ruff, A. W., Discussion on the Paper, "Ferrographic analysis of wear debris from boundary lubrication experiments with a five ring polyphenyl ether," ASLE Trans. 18, No. 3, 162 (1975).

52. Ruff, A. W., Quantitative methods in wear debris analysis (Proc. Intl. Conf. on Wear of Materials, St. Louis, MO, Apr. 26-28, 1977), Wear 46, 263-272 (1978).

Wear debris has been recovered from a number of test systems and analyzed using different methods. A magnetic debris recovery method was quantitatively evaluated using actual debris samples and collections of manufactured particulates having known sizes and compositions. Small spheres, some containing nickel, were used to simulate debris. Other particulates in different size ranges were used to investigate size resolution, lubricant dilution techniques, particle overlap difficulties, and the general problem of calibration of debris recovery system. A comparison between chemical analysis and particulate analysis is presented. The application of optical and electron microscope methods and x-ray microanalysis in characterizing the wear particulates was carried out.

53. Scott, P. B., Johnson, S. E., Watson, G. W., Berger, H., Neutron radiographs using the ionographic process, J. Appl. Phys. 49, No. 10, 5078-5080 (Oct. 1978).

Thermal neutron radiographs have been made using ionographic techniques. With a fluence of  $10^7$  neutrons/cm<sup>2</sup> at the image plane, image resolution of three line pairs per mm was demonstrated. It appears possible to make ionographic neutron radiographs using a transmitted fluence of  $10^6$  neutrons/cm<sup>2</sup>.

54. Shorten, F. J., Ed., NBS Reactor: Summary of activities July 1976 to June 1977, Nat. Bur. Stand. (U.S.), Tech. Note 969, 188 pages (Apr. 1978) SN003-003-01907-1, \$3.50.

This report summarizes all those programs which depend on the NBS reactor. The programs range from the use of neutron beams to study the structure and dynamics of materials to sample irradiations for neutron radiography and nondestructive evaluations.

55. Teague, E. C., Uncertainties in calibrating a stylus type surface texture measuring instrument with an interferometrically measured step, Metrologia 14, 39-44 (1978).

56. Tighe, N. J., Wiederhorn, S. M., Fracture of brittle materials at high temperature, Report AFML-TR-78-83, 48 pages (Air Force Materials Laboratory, Wright-Patterson Air Force Base, OH, July 1978).

The brittle nature of ceramic materials requires a design approach based on consideration of crack nucleation and growth. If the initial sizes of pre-existing cracks and their rates of growth are known then the time to reach critical size can be predicted. However, state-of-the-art NDT equipment does not have the sensitivity to detect the flaws in question, which are generally 100 micrometers or less. An upper limit on tolerable flaw size can be obtained by proof testing, but the validity of this approach needs to be demonstrated.



57. Wiederhorn, S. M., Tighe, N. J., Application of proof testing to silicon nitride, Proc. ERDA Workshop on Ceramics for Advanced Heat Engines, Orlando, FL, Jan. 24-26, 1977, pp. 247-258 (Available as ERDA CONF-770110 from NTIS, 1977).
58. Yonemura, G. T., Light and vision, Paper in Developments in Lighting-1, J. A. Lynes, Ed., Chapter 2, 25-45 (Applied Science Publishers Ltd., Essex, England, 1978).

Three levels of visual information needs are defined. The criteria for recommending levels of illumination should be 'goodness of seeing' rather than 'just barely able to see'. Blur is introduced as a parameter that has been neglected in task description for lighting. The relative contributions of physiological and psychological variables in visual task performance studies are discussed.

59. Zapf, T. L., Harvey, M. E., Larsen, N. T., Stoltenberg, R. E., Ultrasonic calorimeter for beam power measurements from 1 to 15 megahertz, (Proc. 1976 Ultrasonics Symp., Annapolis, MD, Sept. 29-Oct. 1, 1976), IEEE Cat. No. 76CH 1120-5 SU, pp. 573-576 (Institute of Electrical Engineers, New York, NY, 1977).
60. Blackburn, D. L., Larrabee, R.D., Automated photovoltaic technique for nondestructively measuring resistivity variations of high resistivity silicon slices, (Proc. Topical Conf. on Characterization Techniques for Semiconductor Materials and Devices, Seattle, WA, May 21-26, 1978), Chapter in Electrochemical Society, P. A. Barnes and G. A. Rozgonyi, Eds., 78-3, 168-179 (Electrochemical Society, Princeton, NJ, 1978).

An automated, nondestructive photovoltaic technique for measuring the resistivity variation of high resistivity slices is described.

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Various measurement schemes utilizing surface or bulk elastic waves are described with emphasis on approaches to overcome problems with the field of coverage, transducer coupling effects, texture-related effects, calibration and resolution. Some analytical work is also described.

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We review signal processing techniques used to characterize detected AE signals and then report an experimental system consisting of a large plate, a mechanical step-impulse simulator, and a capacitive transducer. The transfer function of the plate can be computed; it provides a basis for analysis. The transfer function of the transducer is shown to be true displacement measurements. The system is used to explicitly determine unknown sources in terms of force-time functions through a time-domain deconvolution algorithm. The system also provides means to characterize sensors and structures. Finally, we compare spectral and direct time-domain analyses.

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Broadband ultrasonic pulses and monochromatic ultrasonic waves are visualized in transparent solids using a photoelastic technique. Application is made to the characterization of the sound field radiated by various transducers operating under various excitation and coupling conditions.

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This paper is a review of the results of experiments and their interpretation of the scattering of bulk ultrasonic pulses from various smooth and crack-like obstacles imbedded in an elastic solid. For smooth obstacles, either arrival time or spectral analysis of scattered signals can be used to characterize such obstacles. Crack size can be ascertained from the time delays of various signals scattered by the crack.



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